Obligatory assignment 2 in TEK5010 Multiagent systems 2022

Report delivery date November 9 by e-mail to hjmoen@its.uio.no.

The report should contain answers to all the questions, include discussions on simulation results in the form of graphs, tables or figures, and an appendix with the simulation program code. The report should be delivered as a pdf file. You can use any programming language of your choosing for this oblig.

Search for weed in crops using multiagent systems: Analytic modelling

Background:

In the obligatory assignments this year we are going to explore search problems in multiagent systems (MAS). Search problems are considered a general class of problems in MAS and many real-world problems could be formulated as search problems. In the first oblig we are going to study search problems using numerical micro scale simulations and in the second oblig we are going to employ a more analytic approach for solving the same search problem. The goal is to illustrate how we could use numerical data from direct simulations to make an analytical model connecting micro scale parameters with aggregated system performance.

One real-world search problem is to detect weed in crops before they become large scale problems of high cost [1]. There are many types of weed [2], but they could all potentially be detected using the right kind of electrooptical camera (video, infrared and hyper spectral) deployed on an elevated UAV platform searching the fields [3, 4]. In general, the detection performance (e.g. how many sites of weed that could be found in time) depends on the detection area projected on the ground (i.e. the camera pixel density needed to obtain a required sensitivity), the speed of the UAV platform and, of course, the size of the search field.

Definition of the search problem:

The *search area A* is a bounded square spanned by the two points (0, 0) and (X, Y).

The *N agents* move randomly around the search area at a speed *v*.

The different *sites of weed* are randomly distributed over the search area, in MAS they are called *tasks T*. As soon as a site of weed or task is discovered a new task is spawned at a random position in the search area. A task is discovered if an agent is within the task radius *Tr* of a task, i.e. *Tr* is the same as the agents projected detection radius on the ground in the search area.

In equilibrium setting, we can evaluate how long time on average the system takes between detections of tasks.

Questions:

a) Since you made such a convincing analysis in last oblig, the scope of the problem is now extended to a larger search area and one wants to find the weed much earlier in its growth than in oblig 1, requiring a much smaller detection radius on the ground.

   So, how long time on average would one agent N=1 use to find one task in the search area moving around at speed v=10 km/h in a square search area of 10 km^2, if the projected detection radius is Tr=0,5 m?

b) How many agents would you need if you wanted to complete the job in 1 hour? You probably have exhausted your computing resources for completing this question. Discuss your options.
   Hint, the results from exercise L6 on response thresholds might be useful.

References

[1] Chauhan BS (2020) Grand Challenges in Weed Management. Front. Agron. 1:3. doi: 10.3389/fagro.2019.00003, https://www.frontiersin.org/articles/10.3389/fagro.2019.00003/full#B24

[2] NDLA-artikkel, Ugras i kornåker, https://ndla.no/en/subject:169ba831-b3cd-4207-b9b8-7d06bf03328b/topic:a82f6884-61da-47b3-a17f-18042391103a/topic:961bcf5a-0820-431b-ad38-cccc374bbf00/resource:1:148393

[3] Vijay Singh, Muthukumar V. Bagavathiannan Bhagirath Singh Bagavathiannan and Sama Singh, Evaluation Of Current Policies on the use of Unmanned Aerial Vehicles in Indian Agriculture, Scholarly Works, Virginia Agricultural Experiment Station, 257,

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[4] Hunt Jr, E. R. and Daughtry, C. S., What good are unmanned aircraft systems for agricultural remote sensing and precision agriculture? Int. J. Remote Sens., 2018, 39, 5345–5376, https://www.tandfonline.com/doi/full/10.1080/01431161.2017.1410300